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Electrophysiology correlates of successful and impaired auditory discrimination in acquired comprehension impairments.

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Introduction

Acquired comprehension impairments following lesions to the posterior superior temporal cortex are associated with deficits in auditory processing (Robson et al., 2012; Robson et al., in press). Speech sound discrimination in such individuals is severely impaired but not absent; discrimination can be achieved with stimuli which are sufficiently perceptually distinct. As therapy often attempts to remediate this discrimination deficit it is important to investigate the neural dynamics underlying auditory processing. This study used electroencephalography (EEG) to investigate neural responses associated with successful and impaired auditory discrimination in Wernicke's aphasia (WA).

Methods

EEG recordings were collected from seven chronic WA and seven hearing- and age-matched control participants during a multiple-deviant mismatch negativity (MMN) auditory oddball paradigm. MMN data were collected for two conditions, pure tones (PT) and CVC syllables. Two oddball types were presented in each condition, one perceptibly different from the standard stimulus ('deviant-above') and one acoustically but non-perceptibly different from the standard stimulus ('deviant-below'). Parameters of the stimuli for each condition were based on discrimination thresholds[2] measured before EEG recording.

2x2x2 ANCOVAs, Group x Condition x Oddball-type, co-varied for hearing, investigated differences in MMN morphology (amplitude, latency and lateralisation). Partial correlations, co-varied for hearing, examined the relationship between MMN morphology and discrimination measures. Non-zero phase-lagged coherence (Drakesmith et al., submitted) was calculated in theta band and compared between oddball types.

Results

ANCOVA results revealed a significant group-x-condition interaction for peak latency ($F_{(1,11)}$ = 5.66, p = 0.037) driven by longer latencies in the CVC condition in the WA group. No other significant differences were found, perceptibility was not differentiated by ERP morphology.

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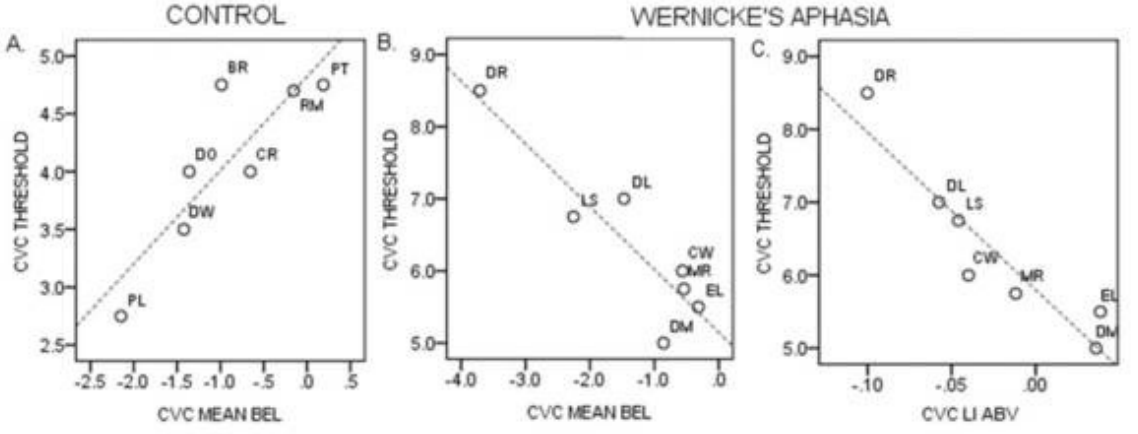
Partial correlations revealed a significant relationship between *deviant-below* MMN amplitudes and CVC discrimination thresholds in both groups (control: r = 0.94, p = 0.005; WA: r = -0.908, p = 0.012) but the direction of the effect differed. The control group displayed a direct correlation (greater amplitude corresponding to better discrimination) whereas the WA group displayed the inverse effect. The WA group showed a significant relationship between CVC thresholds and *deviant-above* MMN peak amplitude lateralisation (r = -0.937, p = 0.007); the greater the leftward distribution the better the discrimination (see Figure). There were no significant relationships between PT MMN data and behavioural testing once peripheral hearing was accounted for.

Comparison of the CVC deviant-above and deviant-below coherence networks revealed significant perceptibility-related differences in both groups. In the WA group, the deviant-above network displayed greater inter-hemispheric temporal lobe coherence and right temporal-left frontal coherence, whereas the deviant-below network displayed greater left temporal-right frontal coherence.

Discussion

This study indicates that behavioural auditory discrimination accuracy in WA is accounted for by alterations in neural network dynamics rather than magnitude of neural response. Coherence results may provide a framework to evaluate therapy induced auditory discrimination changes.



A. Correlation between control participant CVC discrimination thresholds (smaller value corresponding to better discrimination) and deviant-below MMN peak amplitude. B. Correlation between WA CVC discrimination thresholds and deviant-below MMN peak amplitude; correlation is inverse of controls. C. Correlation between WA CVC discrimination thresholds and lateralisation index (positive values indicate leftward distribution) for deviant-above MMN peak amplitude.

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